Space Weather Technical Forecast

Issued on Friday, 01 April 2022 at 01:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares likely throughout. Slight chance of further S1 or above solar radiation storms. G1-G2/Minor-Moderate geomagnetic storms likely Days 1 and 2 (1st and 2nd April).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been at Moderate levels over the past 24 hours, with an M9.6 flare at 31/1835 UTC, which originated from AR2975, subsequently resulting in R2 radio blackouts. The flare from AR2975 produced a coronal mass ejection (CME), and this may be Earth-directed.

There are currently four numbered sunspots on the visible disc, of which three are large and magnetically complex, including AR2975 which has emitted isolated M or X-class flares over the past two days. There are also three small and simple, yet to be numbered, regions on the visible disc.

Solar Wind / Geomagnetic Activity: Solar wind speeds started the period at slightly elevated levels. On the arrival of a coronal mass ejection (CME) at 31/0140 UTC the solar wind became elevated, and peaked at strong levels of 629 km/s at 31/1148 UTC. Towards the end of the day the solar wind speed gradually declined, ending the day at slightly elevated levels again, around 470 km/s. The density was near average initially, then increased above average around 31/0130 UTC with a peak of 51 ppcc at 31/0258 UTC. After this the density gradually declined, ending the day below average. The strength of the IMF, Bt, started weak and below 6nT before becoming moderate to strong on arrival of the CME, peaking at 23 nT around 31/2300 UTC. The north-south component, Bz, was weak initially before becoming moderately negative at times during the onset of the CME, reaching -12nT at 32/0522 UTC. Through the afternoon the Bz become positive, while gradually increasing, ending the day around -17nT. The Phi angle fluctuated for much of the day, but ended the period positive (away from the Sun). Geomagnetic activity was Active to minor storm (G1) levels (Kp 4-5) until the evening, then decreased to become Quiet (Kp 2).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured at GOES-16 showed an increase following the strong flare to reach minor storm (S1) levels for a short period around 31/0600 UTC, but has since gradually declined, although remaining above background levels. The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO was at background to occasionally moderate levels, with a peak of 144pfu at 31/2005 UTC. The observed fluence at 01/0001 UTC was 1.3e6 integrated pfu, having seen a sharp declining trend at through the evening.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with further M-class flares likely, and a slight chance (15%) of another X-class flare, this most likely emanating from AR2975.

Solar Wind / Geomagnetic Activity: The 28th March CME(s), arrived in the early hours of 31 March, and the resulting slightly elevated solar winds are anticipated to continue today (1 April).Tomorrow a further CME is forecast to produce a geomagnetic enhancement (2 April), probably early in the day, but confidence is currently low for the detail. A fast wind from coronal hole(s) influence is also forecast to become geoeffective tomorrow (2 April).

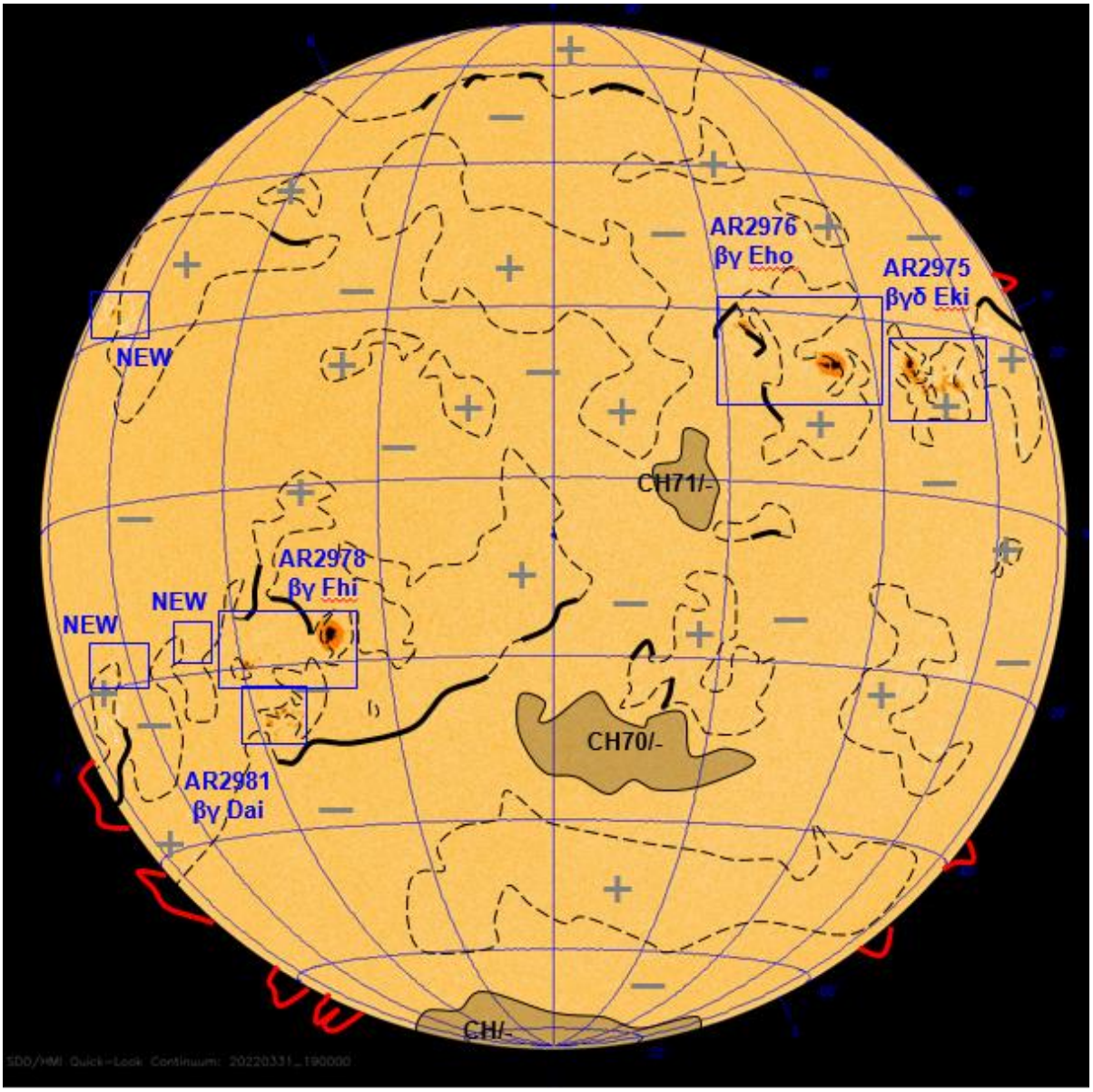
Active to Minor or Moderate?g1-G2 (Kp 4-6) storm periods are likely today and expected tomorrow. The CME from the X-Class flare on 30 March will probably give a glancing blow to Earth tomorrow (2nd), before gradually easing later in the day and through day 3 (3rd). However, geomagnetic activity may remain Unsettled to Active (Kp 3-4) Days 3 and 4 (3rd and 4th April) due to a possible fast wind from a coronal hole(s) influence.

Energetic Particles / Solar Radiation: The continued activity of AR2975 in particular gives the slight chance of further potential enhancements above the S1 threshold during the period.
A flat trend is expected at first in the high energy (greater than 2 MeV) electron flux. However, from Day 1 (1st April) confidence becomes low with the CME arrivals likely to at least temporarily reduce flux levels. Thereafter, some erratic fluctuation is likely, but with a possible eventual rise towards the end of the period. Despite this the associated 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 1. Solar Analysis Valid 31/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

The 28th March CME(s), arrived in the early hours of 31 March, and the resulting slightly elevated solar winds are anticipated to continue today (1 April).Tomorrow a further CME is forecast to produce a geomagnetic enhancement (2 April), probably early in the day, but confidence is currently low for the detail. A fast wind from coronal holes 70 and 71 is also forecast to become geoeffective tomorrow (2 April).

Active to Minor-Moderate/G1-G2 storm periods are likely today, and expected tomorrow. The CME from the X-Class flare on 30 March will probably give a glancing blow to Earth tomorrow (2nd), before gradually easing later in the day and through day 3 (3rd). However, geomagnetic activity may remain Unsettled to Active (Kp 3-4) Days 3 and 4 (3rd and 4th April) due to a possible influence of CH70 and CH71.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	60	80	40	10
Strong	G3	No	5	20	1	1
Severe	G4	No	1	5	1	1
Extreme	G5	No	1	1	1	1

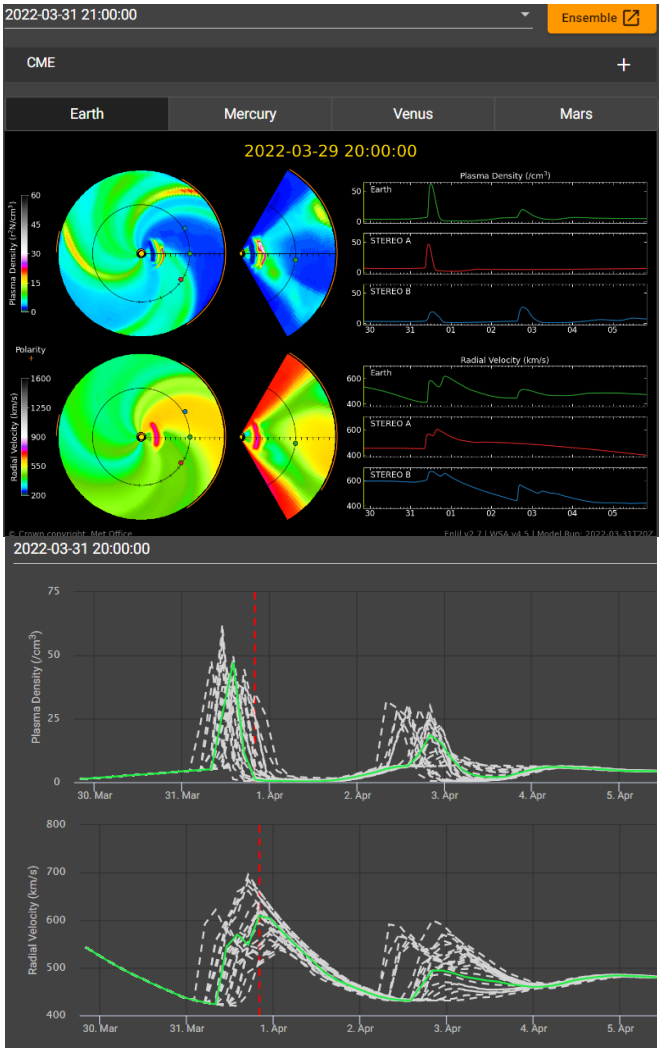
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
30/2315	Halo	2975	NW quadrant	700	02/1800 UTC	Limited shock possible. Most of material passes Earth. Low confidence.

Figure 2: Latest Met Office ENLIL forecast (top) and ensemble forecast (bottom).

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

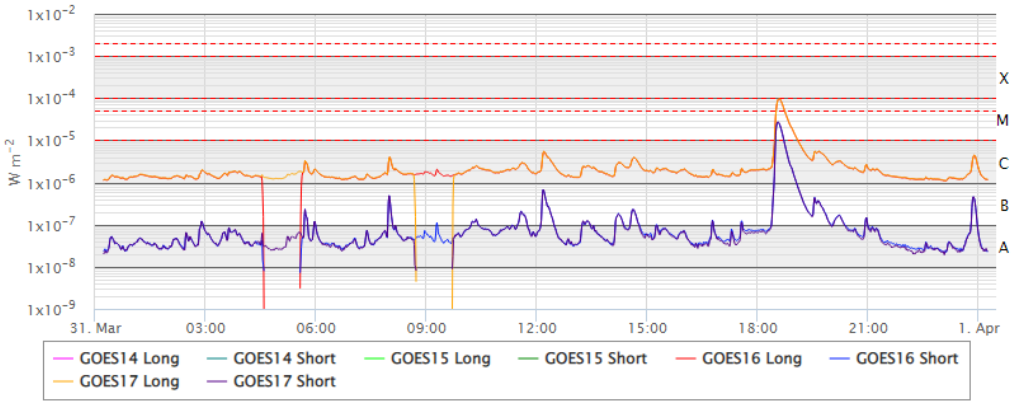
Radio Blackouts - X-Ray Flares:

There are currently four numbered sunspot regions on the visible disc; AR2975 (NW quadrant) remains magnetically complex. This is currently classified as a Eki/Beta-Gamma-Delta, with a possible small delta spot. This region produced a M9.6 flare at 31/1835 UTC. AR2976 also in the northwest quadrant has lost its previous intermediate spots, whilst gaining some faint trailing spots. AR2978 continues to rotate across the SE quadrant. The large lead spot remains unchanged, whilst a few small and faint intermediate spots have emerged, and it is now classified as Fhi/beta-gamma. AR2980 in the southwest remains small and stable. Three NEW unnumbered regions persist in the eastern hemisphere, all simple and uni-polar.

Solar activity has been Moderate, with the largest flare of the past 24 hours an M9.6 at 31/1835 UTC, which originated from AR2975. For most of the forecast period there is a 70% probability of further M-class flares, and a slight chance (15%) of X-class flares. However, for day 4 (4th) the probabilities drop slightly, as during day 4 (4th) AR2975 will rotate behind the western limb.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	70	70	70	60
Very Active	R3 to R5 X Class	No	15	15	15	10

Figure 3: X-ray flux for the past 24 hours.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

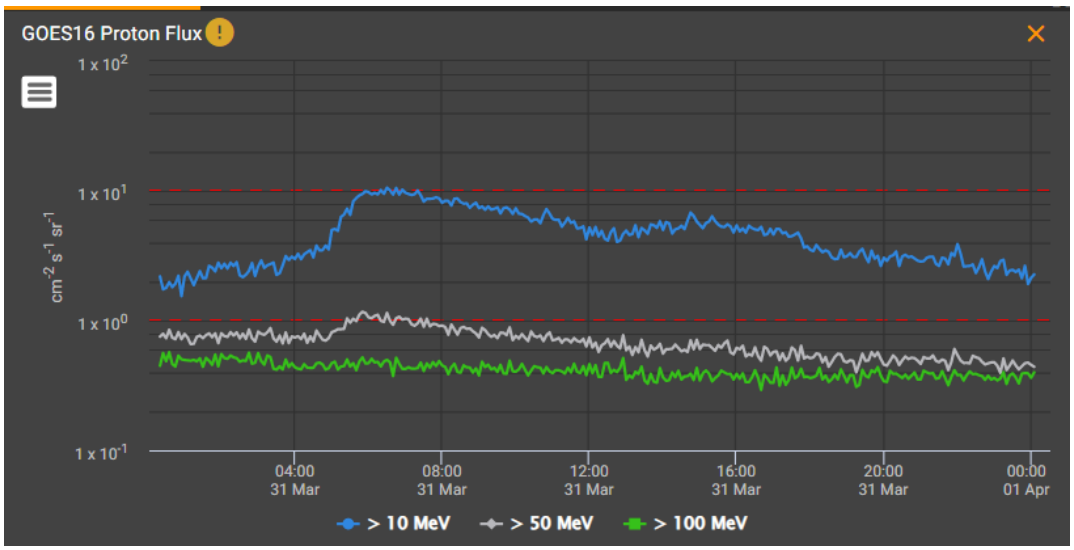
© Crown Copyright 2022. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES-16 temporarily reach the S1 level, but is now gradually declining. The continued activity of AR2975 in particular gives the slight chance of further potential enhancements above the S1 threshold during the period, although by the end of the period AR2975 will have rotated off the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	20	20	10	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Latest GOES16 Proton Flux



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

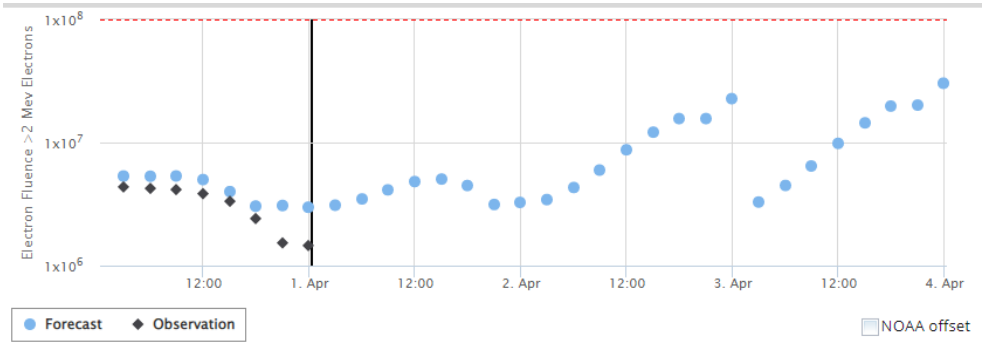
High Energy Electrons Event (≥ 2MeV):

A flat trend is expected at first in the high energy (greater than 2 MeV) electron flux. However, from Day 1 (1st April) confidence becomes low with the CME arrivals likely to at least temporarily reduce flux levels. Thereafter, some erratic fluctuation is likely, but with a possible eventual rise towards the end of the period under potential influence of coronal holes 70 and 71. Despite this the associated 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

The Met Office REFM is considered to be giving reasonable guidance, keeping the fluence below the Active threshold over the next 3 days, but with an increasing trend later in the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	10	30	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	5	5

Figure 5: Met Office REFM model.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.